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## MDA Program Test Structure and FIRE Implementation

by

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1 Mar 2008

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**13. ABSTRACT (Maximum 200 words.)**
An objectives and metrics structure has been designed for Maritime Domain Awareness tests. This structure has been installed in the NPS FIRE knowledge management system. This report describes the structure and its use for MDA test planning and reporting.

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# Executive Summary

The Naval Postgraduate School was contracted by NAVNETWARCOM / SPAWAR PEO C4I to develop objectives and metrics for MDA evaluation, to include Spiral-1 system assessments and follow-on full operational capabilities assessments.

NPS applied a robust method for military testing/experimentation. That method, previously developed for Trident Warrior and other assessment events applies:

- A structure for defining program objectives and goals.
- A structure for defining metrics.
- Methods of specifying data requirements for operational and tactical events.
- Methods of rapidly generating reports from collected data on metrics pertinent to program objectives and goals

The FORCEnet Innovation and Research Enterprise (FIRE) knowledge management system provides robust support for applying this method and managing the knowledge it produces. In particular, FIRE provides forms for planning and reporting within and across events. It also provides work and collaboration spaces.

NPS applied this method and infrastructure to develop an MDA-specific structure of objectives and metrics. Authoritative MDA documents served as the foundation for this work. This status report:

(1) Describes the NPS method for developing objectives and metrics and their use in test planning.
(2) Defines the framework NPS has developed for MDA assessment.
(3) Presents objectives and metrics that have been defined from MDA program requirements documentation.
(4) Describes FIRE forms and reports that have been created for MDA program use.

The NPS products for MDA will support the full range of required MDA capability testing for Spirals 1, 2, and beyond, including:

- System capabilities
- Systems support for operations
- Operations process capabilities
- Workflow and information flow
- Guidance documents status
- Organization and cross-organization capabilities
- Cross-organization and multi-national agreements and processes
- Human capabilities

Further, this work will enable the Navy to correlate and fuse findings across many dimensions:

- Across test venues
- Across studies of process, system, organization, human, and guidance
- Across experiments, e.g., Trident Warrior, Empire Challenge, and JMMES JCTD.

The work reported here is in process. NPS has developed an MDA-specific framework of objectives and metrics. Further effort is required to develop measures within this framework, apply them at evaluation events, and report results within events and across the MDA program. NPS recommends that the development of measures continue with a specific focus on generating measures for specific events.

## 1. INTRODUCTION

The Naval Postgraduate School was contracted by NAVNETWARCOM / SPAWAR PEO C4I to develop objectives and metrics for MDA evaluation, to include Spiral-1 system assessments and follow-on full operational capabilities assessments. This report:

(5) Describes the NPS method for developing objectives and metrics and their use in test planning.

(6) Defines the framework NPS has developed for MDA assessment.

(7) Presents objectives and metrics that have been defined from MDA program requirements documentation.

(8) Describes FIRE forms and reports that have been created for MDA program use.

The NPS effort focuses on defining test objectives and their associated metrics to evaluate:

- The operational utility and impact of Spiral 1 technologies
- MDA process capabilities
- Human and organization capabilities
- Quality of MDA CONOPS and TTP documents
- Multi-organization and multi-national agreements

This effort builds on an established method for experiment/test planning[1], and it leverages a special-purpose knowledge management system – FORCEnet Innovation and Research Enterprise (FIRE) – that supports experiment/test planning, results development, and reporting.

Further, the NPS product builds on an authoritative set of MDA resources:

- Campaign Plan for Navy Maritime Domain Awareness Prototypes, 21 Aug 200
- MDA Spiral 1 Overarching T & E Plan, 1 Oct 2007
- Scoping Document, version 4-4, 23 Jan 2008
- Fleet MDA CONOPS, 13 Mar 2007
- MDA Focus Area Brief, ONR S&T Goals presentation, Jul 2007

[1] This process is documented in "FIRE Experiment Planning and Reporting Structure", NPS-IS-07-002, Jul 2007. A second report describes how the products of this process are mapped to JCIDS or other areas of interest: "Mapping Experimental Results to Operational Capabilities," NPS-97-08-001, Nov 2007.

- The MDA Workflow developed by NPS (see the accompanying report) and vetted by representatives of ASN RDA, C3F, COTF, Dept. of the Under Secretary of the Navy, DISA, HFE LLC, JITIC, METRON, MIFCLANT, MIFCPAC, NAVCENT, NAVNETWARCOM, NCIS, NORTHCOM, NPS, NRL, NWDC, ONI, OPNAV, PMW 120, SPAWAR, and MDA Spiral 1 technology experts.

The readers should be aware that this reports documents one of several metrics and measurement efforts for MDA. Those efforts, in combination with the NPS work, define a broad space of MDA metrics. The reader may wish to access these additional efforts if their interests extend beyond the measurement space NPS is addressing. Specifically:

- Measures developed by Mike Shumberger of HFE for the Navy focus on assessment of fleet readiness for MDA operations.
- Measures developed by Fifth Fleet support acquisition and use decisions by operational organizations concerning existing operations.

## 2. FOUNDATIONS

The MDA products described below are built on a foundation that has two dimensions: objectives and metrics. We define those terms below, and then describe how they are instantiated for MDA.

### 2.1 Objectives

Objectives define what is to be learned from an investigation. For MDA these objectives are to assess current capabilities or to develop new ones. A logical objective structure enables us to correlate test results from different venues and to relate them to other areas, such MHQ w/MOC. For the MDA effort, NPS developed an objective structure that consists of two substructures: "program" and "test" objectives.

**Program Substructure**

**Program area:** A major area of interest to the MDA program. *Example: Detect and Track*

**Activity / Focus:** An element or activity within a program area. *Example: Ship Detection*

**Program objective:** A focal element or activity within the MDA activity, *Example: Provide non-radiating ship detection.*

The above is the "program" portion of the structure. It applies to the program as a whole and contains all of the objectives, implied or stated, from the documents listed in Section 1. The Program Objectives for MDA have been input in FIRE so that they can be selected and used, as needed, for specific test venues.

**Test Objectives Substructure**

**Test objective:** A focus of one or more test venues. *Example: Provide automated detection of non-radiating ships.*

**Objective- Goal(s):** A determination to be made or question to be answered at a test venue. Note that objective goals are operationalized by (consist of) situation, specific measures and data (measurements). *Example: Determine if Global Hawk provides accurate and timely detection of non-radiating ships.*

The "test" portion of the structure specifies the objectives and goals to be determined for a particular test venue.

Designing a test involves several more components in addition to the objectives and goals. One also has to define:

- Specific measures
- Data required to produce those measures
- Situations to be set up so that the correct data are captured
- A schedule that combines these components

### 2.2 Metrics

Metrics are the attributes, measures, and standards associated with an activity, such as ISR or support activity such as network-centric operations.

- **Attributes** are single-word expressions of the characteristics of people, things, or processes. *Example: Timely*
- **Measures** quantify attributes. *Example: Average time from submission of RFI to receipt of requested information.* Measures are of several types:
    - Measures of Effectiveness (MOEs) concern how well a technology, organization, or process performs its functions. *Example: Reliable*
    - Measures of Performance (MOPs) concern a specific parameter of a technology, organization, or process. *Example for "reliable" effects: Robust*
    - Measures of Utility (MOUs) concern how well a technology, organization, or process contributes to a military activity. *Example: Needed*
    - Measures of Readiness (MORs) reflect the combined effectiveness and utility of a system, and its life-cycle plan.
- **Standards** are values that specify a satisfactory performance boundary. *Example: Two hours from submission of RFI to receipt of requested information.*

Attributes and measures have meaning only when associated with a task. For example:

- Task: retrieval of data from a local repository
- Attributes: timely
- Measure: latency (or delay) of retrieved information.

In this case, the task helps to specify the meaning of timeliness. The actual measure of interest completes the specification. This association aspect will be covered more completely in Appendix D.

This complete structure, objectives, goals, metrics, and other planning components that define events and data, are provided in the FIRE planning and reporting system. The system contains input/edit forms and reports that show current contents of the test database. FIRE is described in Section 5.

## 3. MDA Use-Case: Scenario and Issues

MDA objectives are complex and multi-threaded. We might, for example, want to evaluate VoI (Vessel of Interest) handoff processes, the systems that support the process, and the associated TTP. In the remainder of this report, we describe how we put the structures above, and FIRE, to work to define objectives and metrics in the MDA program. We illustrate this with a use case, which in essence describes the military operations that will be invoked in a study and what we wish to learn from studying them. Once this has been established, we use the MDA objectives and metrics structure to define the specifics of the test(s) to be undertaken.

In this use-case the following operations take place:

- HUMINT identification of a person-of-interest.
- Ship cargo and personnel identification.
- Non-AIS and AIS ship tracking.
- Information processing and sharing for Situation Awareness.
- Vessel-of-Interest handoff across AORs and nations.
- Vessel boarding.

The MDA issues to be investigated are:

- Database access.
- System interoperability.
- Multi-national and multi-agency cooperation agreements.
- CONOPS and TTP sufficiency.
- Information sharing agreements and information interoperability.
- Information quality for SA and decision-making.
- Boarding communications and surveillance capabilities.
- Boarding data and information collection.

As noted above, the use case and issues identify learning objectives. An issue can apply to more than one operation and an operation can address several issues. Table 1 provides a partial listing of the issues to be addresses for each operation.

| Operations | Issues (notional, not complete) |
|---|---|
| HUMINT | Access to injected HUMINT information. |
| | Timeliness of HUMINT alert. |
| | Access to human information databases. |
| Ship Information | Access to ship manifests. |
| | Ship database access. |
| | Completeness of ship information |
| Ship Tracking | Timeliness and accuracy of AIS reports |
| | Timeliness and accuracy of overhead surveillance. |
| | Timeliness of identification process. |
| | Automated reporting capabilities. |
| VoI Handoff | CONOPS and TTP sufficiency. |
| | Personnel familiarity with handoff process. |
| | Timeliness of handoff completion. |
| | Sufficiency and accuracy of handoff information. |
| | Automated M2M handoff capabilities. |
| Information Processing | GUI usefulness/clarity. |
| | Ability to correlate multi-int information. |
| | Reachback timeliness and sufficiency. |
| | Ability to correlate HUMINT with person database. |
| | Information fusion accuracy. |
| Information Sharing | Multi-national agreements, sufficiency/constraints. |
| | Multi-agency agreements, sufficiency/constraints. |
| | M2M interoperability. |
| | Content and format interoperability. |
| | Distributed information fidelity. |
| Boarding | Available communications bandwidth/throughput. |
| | Communications security. |
| | Communications reliability. |
| | Biometrics kit usability. |
| | Real-time assessment capabilities. |

**Table 1. MDA operations and issues for an example use-case.**

Note: Some issues in Table 1 are highlighted in yellow. They are addressed in Section 6 below.

We leverage this use case in the remainder of this report. Specifically, we:

- Describe the objectives and metrics structure (Section 4).
- Describe use of FIRE for test planning and reporting (Section 5).
- Address the use-case as an illustration of test planning (Section 6).

## 4. MDA Objectives and Metrics

The following is the MDA program structure, a specific instantiation of the objectives and metrics structure described above. In Section 6, we describe application of this structure to specific tests. Appendix E describes how this structure correlates with the JCIDS JCAs.

### 4.1 MDA Objectives

Eight MDA Program Areas have been defined:

- **Detect/Track** – detection and tracking of surface vessels by any means
- **Process** – processing of data and information
- **Analyze/Develop SA** – analysis of processed ship information to provide threat assessment and develop situation awareness
- **Distribute/Share** – distribution and sharing of assessments for course-of-action development and decision-making.
- **Archive/Retrieve** – deploying, maintaining, and updating MDA databases
- **Guidance** – assessment of guidance quality, CONOPS, TTP, directives
- **Workflow** – workflow assessment, including the influences of humans, organizations, and workflow structure

In addition, it was determined that E-MIO operations should be broken out as its own program area from other operations.

- **E-MIO** – operations capability: planning, execution, and information management activities associated with E-MIO

All of the MDA objectives in the reference documents fit within these Areas.

Within each Program Area, several Activities or test foci have been defined. These are presented in Table 2.

| Program Area | Activity / Focus |
|---|---|
| **Detect/Track** | |
| | Ship Detection |
| | Ship Tracking |
| | Acquire Database Information |
| | Intelligence Collection |
| **Analyze/Develop SA** | |
| | Develop Profiles |
| | Request Information |
| | Classify Vessels |
| | Prioritize Information |
| **Archive/Retrieve** | |
| | Deploy Repository |
| | Acquire Information |
| | Authenticate Information |
| | Manage Access |
| | Assure Information |
| **Workflow** | |
| | Task Assignments |
| | Organization |
| | Group |
| | Human |
| | Multi-Organization Workflow |

| Program Area | Activity / Focus |
|---|---|
| **Process** | |
| | Identify Ship's Data |
| | Classify |
| | Correlate |
| | Fuse |
| **Distribute/Share** | |
| | Distribution Means |
| | Collaborate |
| | Disseminate |
| **Guidance** | |
| | TTP & SOP |
| | CONOPS |
| | Standing Orders |
| | Cross-Organization Agreements |
| **E-MIO Operations** | |
| | Information Acquisition |
| | Develop Situation Understanding |
| | Course-of-Action |
| | Boarding Execution |
| | Shipboard Collection |
| | Information Dissemination |
| | Mission Assessment |

**Table 2. First two levels of the MDA program objectives structure.**

Many of the processes in E-MIO are included in the other Program Areas. However, E-MIO is broken out as its own Program Area at the request of those evaluating MDA. This could be accomplished with other operations, if desired.

Within each Activity / Focus several Program Objectives have been developed. Table 3 presents examples for the Detect/Track Program Area. Also shown is the coding used (e.g., DT-ST.1), which is explained below. The full list is presented in Appendix D.

| Program Area / Activity / Focus | Program Objective |
|---|---|
| **DT Detect/Track** | |
| **DT-SD Ship Detection** | |
| DT-SD.1 | Non-radiating-ship detection |
| DT-SD.2 | Radiating-ship detection |
| DT-SD.3 | Plan & Optimize Collection |
| DT-SD.4 | Automated alerting |
| **DT-ST Ship Tracking** | |
| DT-ST.1 | Non-radiating-ship tracking |
| DT-ST.2 | Radiating-ship tracking |
| DT-ST.3 | AIS-broadcasting-ship tracking |
| DT-ST.4 | Handoff |
| DT-ST.5 | All ship tracking |
| **DT-Acq Acquire Database Information** | |
| DT-Acq.1 | Local repository retrieval |
| DT-Acq.2 | Remote repository retrieval |
| DT-Acq.3 | Cross-domain retrieval |
| DT-Acq.4 | Weather & Environment |
| DT-Acq.5 | Reachback/RFI |

Program Objectives are written in shorthand, with the word "Provide" removed. E.g., DT-SD.1 is "Provide non-radiating-ship detection.

Color is used in the table only to show that the Program Objectives belong to the same Activity/Focus.

**Table 3. Example Activity Types for the Monitoring & Collection Activity Category.**

### 4.2 MDA Metrics

As explained above, metrics define the attributes, measures, and standards associated with an activity, such as a network-centric operational or support activity. The measures are enumerated below through their attribute pair. Appendix A contains detailed definition of each attribute. NPS developed the attribute structure for NAVNETWARCOM, which uses it for their CBAs. NPS added Readiness and its components for the MDA program.

Four MOEs form the basis for the structure. They are:

- **Accessible** You can get to it.
- **Reliable** It is there when needed.

- **Capable** It/he/she/they can do the defined job.
- **Usable** You can use it.

Each MOE has a set of included MOP. These 21 MOPs are shown in Table 4.

| | | | | |
|---|---|---|---|---|
| **Effective** | | | | |
| **Accessible** | **Reliable** | **Capable** | **Usable** | **MOE** |
| Capacity | Robust | Sufficient | Clear | **MOP** |
| Available | Persistent | Flexible | Trusted | " |
| Compatible | Secure | Accurate | Manageable | " |
| Extensive | Assured | Timely | Relevant | " |
| Efficient | | Reach | Compliant | " |
| | | Automatic | Deployable | " |
| **Military Utility** | | | | |
| **Improved** | **Needed** | **Applicable** | **Wanted** | **MOU** |
| **Ready** | | | | |
| **Effective** | **Utility** | **Life Cycle** | **Personnel** | **MOR** |
| **Readiness is a roll up of the component readiness measures.** | | | | |

**Table 4. Attribute structures for effectiveness, utility, and readiness.**

Four MOUs were defined:

- **Improved** Improves the performance of operational activities.
- **Needed** Fills a gap in current capabilities.
- **Applicable** Can be applied to activity performance.
- **Wanted** Operational personnel want, will use, the capability.

Note that no MOP equivalents were defined for Military Utility. This is because currently most utility determinations are subjective. Objective determinations can be made, e.g., the number of times a capability is used as a measure for Wanted. The MOPs shown for effectiveness are also appropriate for utility.

In addition, a readiness metric was defined.

- **Ready** Ready is an official procurement term that refers to the system being ready for fielding. As indicated, it is a roll-up of the other fundamental measures and the life-cycle plan (which includes a personnel plan).

## 5. MDA in the FIRE Knowledge Management System

NPS has developed the FORCEnet Innovation and Research Enterprise (FIRE) to provide complete support for experiment and test planning and reporting. An MDA section has been set up in FIRE, implementing the structure described above. In this chapter, we describe the system's capabilities and how it is used.

*It is important to recognize that the objective statements in FIRE are Test Objectives. They are the actual objectives to be achieved and their status addressed in a test venue*

### 5.1 FIRE Structure

FIRE has two basic sections, Planning Forms and Workspace:

**Planning Forms**

- Detailed planning is accomplished through entries in pre-set forms.
- There are three sets of planning forms
  - Objective
  - Data/Events
  - Results
- Each forms set includes
  - Input/Edit form
  - Report that shows the current planning database content

**Workspace**

- Contains collaboration capabilities and folders for information to be shared
- Pre-created folders and user defined folders
- Check-in/check-out library for document version control

Following is a depiction of the principal components of the planning forms.

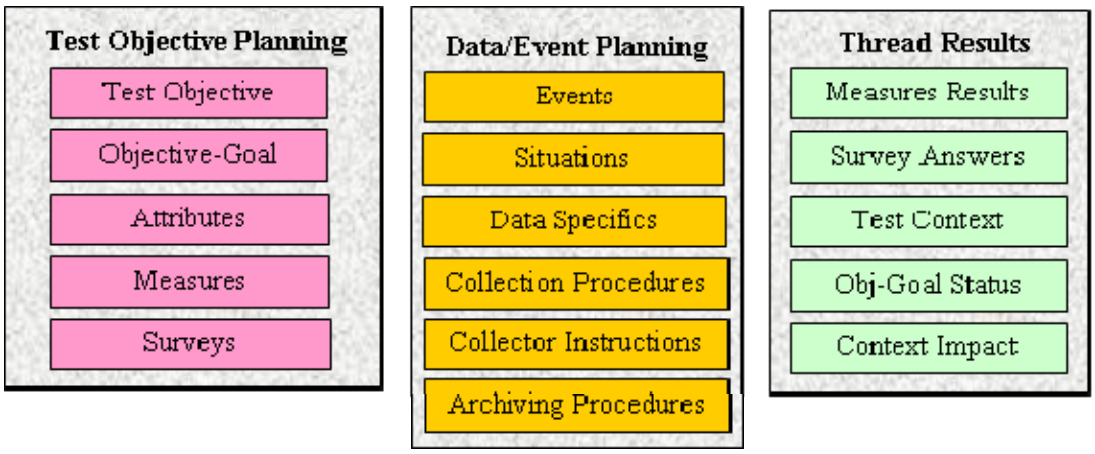


**Figure 1. Principal components of the MDA planning forms in FIRE.**

**To plan a test (see**
Figure 2), we use both the forms (left) and the workspace (right) in a sequence such as the one illustrated here (center).

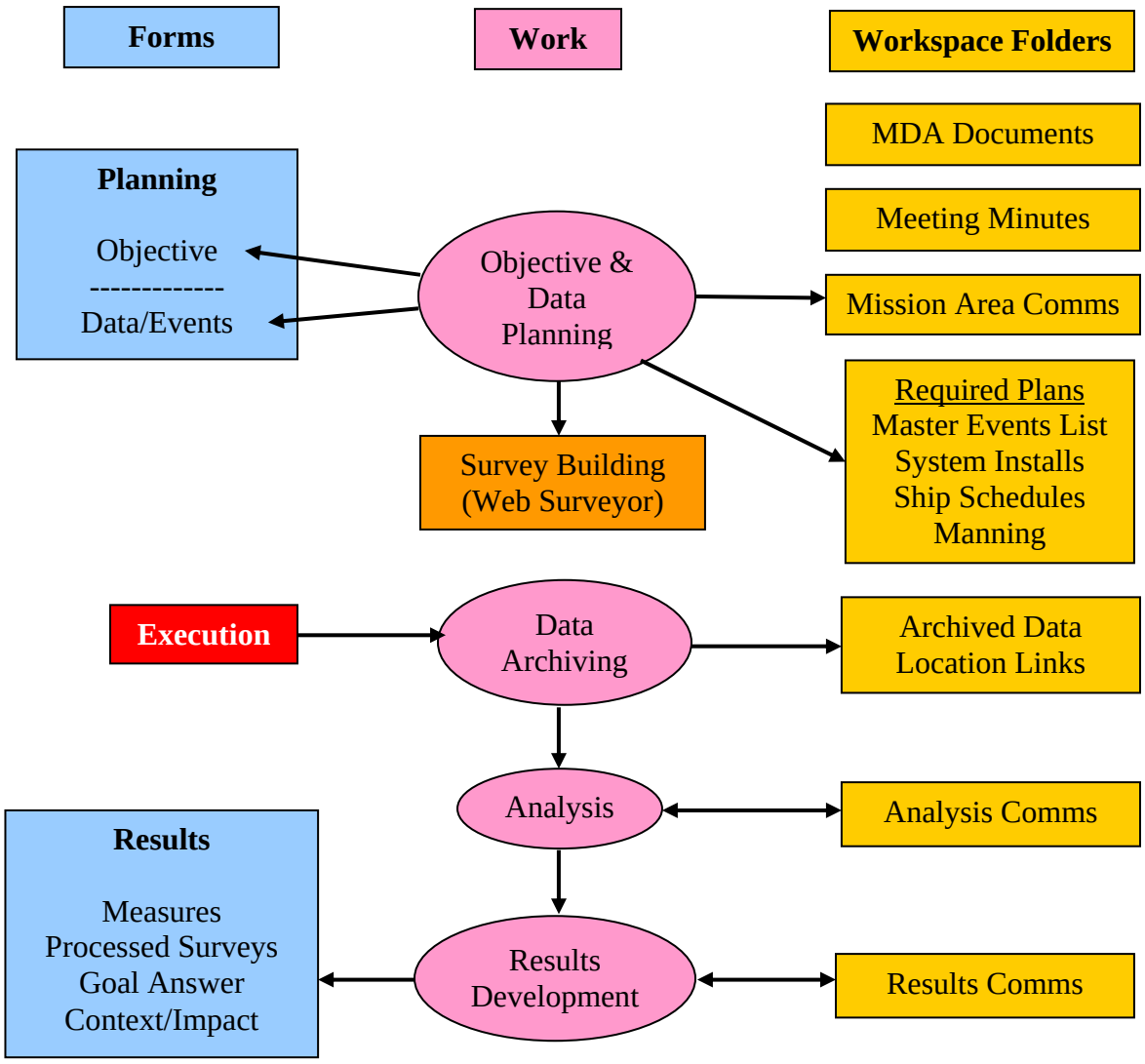


**Figure 2. Schematic of FIRE forms and workspace use.**

### 5.2 FIRE Forms Use

The MDA objective planning forms in FIRE have been installed with the following information pre-installed in the objective planning forms. This has been done for each Mission Area.

- Test Objectives
- Objective-Goals
- Goal Attributes
- Measures for each Goal Attribute
- Survey questions for each Goal

It is expected that the pre-installed planning entries will need some modification. Those entries are for the MDA program in general and will need to be made specific for the particular test venue. For example, an objective and objective-goal for ship tracking is written system-agnostic. That is, we have no prior system-specific expectations in our assessment methodology. The particular system being tested in the venue will need to be inserted in the goal statement.

The modification process proceeds as follows for each test to be done:

- Choose the Test Objective to be investigated, e.g., a ship tracking objective.
- Chose the Objective-Goal under that Objective, e.g., system interoperability for handoff.
- Modify the goal statement for
    - Systems to be tested
    - Particular attribute to be determined, e.g., timely, accurate, sufficient
- Specify the exact measure to be determined, e.g., beginning and end points for timeliness
- Specify the data source
- Specify any survey questions, e.g., was information handoff accurate…

The above steps are done using the Objective Planning forms. Details of events and data capture are specified using the Data/Event Planning forms.

Some of these steps will be illustrated for the use-case in Section 6.

As noted above, the FIRE forms include reports of what is contained in the database. There is a report for:

- Each Objective-Goal
- Each of the three forms
- Each Venue

There are not separate FIRE databases for each venue. As test venues are added, its reports are placed above those for preceding venues, including a visual delineation.

## 6. MDA Use Case: Test Development

The MDA framework defined above is used to develop test objectives, goals, and metrics. Here, we define several MDA program objectives that bear on the use case defined in Section 2. Five issues to be addressed are highlighted in yellow in Table 1. Appendix D contains the complete list of MDA Program Objectives and associated attributes, with an objective code which is used here.

### 6.1 Issues Addressed and Program Objectives

Table 5 shows the issues addressed here, again highlighted in yellow. The table also includes the corresponding MDA Program Objectives and their codes.

| | Code | Program Objective |
|---|---|---|
| Ship Tracking | | |
| | Timeliness and accuracy of overhead surveillance | |
| | DT-ST.1 | Non-radiating-ship tracking |
| | DT-ST.2 | Radiating-ship tracking |
| VoI Handoff | | |
| | CONOPS and TTP sufficiency | |
| | G-TTP.4 | Operational/Tactical Threads |
| | G-CON.4 | Operational/Tactical Threads |
| | Personnel familiarity with handoff process | |
| | W-Hum.2 | Task Understanding |
| Information Processing | | |
| | Information fusion accuracy | |
| | Proc-Fus.2 | Develop Ship Folder |
| | Proc-Crl.1 | Multi-Source Fusion |
| | Proc-Crl.3 | Reference Data Fusion |
| Information Sharing | | |
| | Content and format interoperability | |
| | DS-Mns.2 | Format for Distribution |
| Boarding | | |
| | Communications reliability | |
| | DS-Dis.1 | Optimize Paths |
| | DS-Dis.3 | Push Information |

Note that the Program Objective descriptions in Table 5 are shorthand for the complete objective statements in FIRE.

**Table 5. Use-case issues and corresponding MDA Program Objectives.**

### 6.2 Using FIRE for Planning Test Objectives and Objective-Goals

The first letters in the codes shown in Table 5 indicates the Test Area (organized on tabs in FIRE[2]).

- DT = Detect/Track
- Proc = Process Data and Information
- AD = Analyze/Develop Situation Understanding
- DS = Distribute/Share
- DB = Database Archive/Retrieve
- W = Workflow
- G = Guidance
- MIO = E-MIO Operations

For definition of the rest of the code see Appendix D.

Most of the issues shown in Table 5 address supporting technologies. Thus the full Test Objective and Objective-Goal statements address systems. However, there are also two Guidance and one Workflow issues.
Table 6 contains the Test Objective and Objective-Goal statements for each of the issues. Note that the technology objectives begin with the word "provide" or "develop". This is because the purpose of the MDA program is to provide capabilities. Objective-Goals are specific "determinations" that assess the status of the objective.

Systems are referred to as "system SSS" in Table 6. For actual tests the name of the system used would be inserted.

> Actual test Objective-Goals would be written more completely than the illustrations presented here. Those shown here are to illustrate the development process, not for actual use.

Colors are used to easily distinguish a particular Test Objective and its Objective-Goals (simply labeled Goal in the table). Test Objectives colored red: indicate that it was decided during test planning that they would not be attempted, for reasons not given. This is not an unusual occurrence during planning.

[2] At the time of writing this report the Program Objectives and Test Objectives are being formulated and input to FIRE. Thus, the below objectives statements may not be exactly the same as the final FIRE content.

| | |
|---|---|
| DT-ST.1 | Provide automatic tracking and reporting of non-radiating VoI across the full AOR. |
| Goal A - | Determine the accuracy and timeliness of system SSS VoI tracking. |
| Goal B - | Determine the number of ships in the AOR that system SSS can simultaneously track. |
| DT-ST.2 | Provide systems that automatically track and report on radiating VoI across the full AOR. |
| Goal - | Determine the persistence, fraction of time, that system SSS can track each VoI. |
| G-TTP.4 | Develop and evaluate TTP for MDA operations. |
| Goal A - | Determine which VoI handoff processes are covered by TTP |
| Goal B - | Determine which VoI handoff situations are covered by TTP |
| G-CON.4 | Develop and evaluate CONOPS for MDA operations. |
| Goal - | Determine which nation's/unit's roles/responsibilities are covered by CONOPS. |
| W-Hum.2 | Evaluate individual understanding of assigned task performance. |
| Goal A - | Determine the amount of time required for MOC personnel to accept VoI handoff. |
| Goal B - | Determine MOC personnel perceived level of understanding of handoff procedures. |
| Proc-Crl.1 | Develop processes for fusing information from multiple intelligence sources. |
| Goal - | Determine which info sources system SSS can automatically fuse. |
| Proc-Fus.2 | Develop processes for correlating multi-source ship information into one assessment. |
| Goal - | Determine compatibility of each ship information source with system SSS requirements. |
| Proc-Crl.3 | Develop processes for fusing reference database information with real-time information. |
| DS-Mns.2 | Develop a means for formatting information for distribution to multiple users. |
| Goal A - | Determine the number of formats that can be automatically generated by system BBB. |
| Goal B - | Determine accuracy after reformatting. |
| DS-Dis.2 | Provide collaboration capabilities to distributed, disparate operational units. |
| Goal A - | Determine the number of users system CCC can have in a single collaboration session. |
| Goal B - | Determine the number of collaboration services provided by system CCC. |
| Goal C - | Determine the bandwidth required by system CCC. |
| DS-Dis.3 | Push information to distributed, disparate operational units. |

**Table 6. Use-Case Test Objectives and Objective Goals.**

### 6.3 Additional Use-Case Planning Components

The discussion above illustrates how objectives and goals are planned using the NPS framework and FIRE. As noted in Section 5.1, there is a great deal more detailed planning to be done. Some of these MDA planning components (events, data, etc.) are already in FIRE; many are not. Even those that are there will probably need to be modified to be correct for a specific MDA test. To illustrate the key components of planning, we document the planning for two goals in Table 7. All of the input forms for these components are in FIRE. There are many more planning components than those shown in Table 7.

| DT-ST.1 Provide automatic tracking and reporting of non-radiating VoI across the full AOR. | |
|---|---|
| Goal A - Determine the accuracy and timeliness of system SSS VoI tracking. | |
| Measures | Accurate: Report location error (km).<br>Timely: Average and maximum time between reports, all ships and VoI. |
| Data Source | system SSS logs, ship navigation logs. |
| Survey | Is SSS reporting of ship positions sufficient to maintain SA? |
| Situations | System SSS in operation. Identified VoI in the AOR. |
| Goal B - Determine the number of ships in the AOR that system SSS can simultaneously track. | |
| Measures | Capacity: Number of ship tracks displayed by system SSS.<br>Capacity: Number of ship tracks managed by system SSS. |
| Data Source | system SSS logs, including display log. |
| Survey | How many ships can be distinguished in the system SSS display?<br>Can the VoI be distinguished from other ships in the display? |
| Situations | System SSS in operation. Identified VoI in the AOR. |

**Table 7. Additional planning components for ship tracking test.**

# Appendix A
**Attribute Definitions**

**Effective** – Effective is an overarching attribute. It refers to how well systems, people, and processes meet their stated purposes. This attribute has meaning only in reference to that purpose. E.g., it is not sufficient to state that a system is effective without also stating at what.

**Accessible** – Users have access to needed capabilities and information. This includes access to communication means, data and processed information, systems, software, support, etc. Access will often be through a network. This attribute is one of the four MOE; its component MOP follow.

> **Capacity –** Number of users that can have access; number of services that can be provided; capacity of other systems required for its function, primarily bandwidth. Included is information or service throughput.
>
> **Available** – System or capability is ready for use, can be used, when needed. It is possible that a capability can be accessed but cannot be used at that time.
>
> **Compatible** – The system or capability can function with other elements external to it without modification to either. It can be integrated with other systems or capabilities. This can also refer to processes or organizations being compatible or integrated.
>
> **Extensive** – The system or capability is capable of servicing a large number of users, covers a large geographical area, services a large number of user types, provides a number of different types of service.
>
> **Efficient** – The number of steps or effort needed to access and use the service is acceptable. This attribute is inherently comparative. Acceptable normally refers to a standard, or an improvement over what was formerly required. Efficiency can be a ratio, a judgment of (result obtained)/(effort required).

**Reliable** –The capability or information is there when needed, can be depended on. Human and organization reliability is included. This attribute is one of the four MOE; its component MOP follow.

> **Robust** – The system or process is able to withstand stress or attack. Changes in environment are managed with minimal loss of functionality or effectiveness.
>
> **Persistent** – The system maintains its status over long periods of time (primarily ISR capabilities). Information maintains its content and meaning across processing and distribution means (e.g., tracks).

**Secure** – The system, process, information, has provisions that prevent unauthorized use, intrusion, or tampering.

**Assured** – Information is warranted to be correct, the source identified, and non-repudiation in effect. The process is warranted to produce the desired result.

**Capable** – The system, capability, person, or organization provides the needed services. This attribute is one of the four MOE; its component MOP follow.

**Sufficient** – What has been provided/received is adequate for the recipient to perform their function. For humans and organizations, the skills available are adequate for task performance. Sufficiency can refer to either quantity or level.

**Flexible** – The system, process, human, or organization responds easily to the situation or to changing requirements. It is adaptable, can handle/utilize a wide range of types. It is tailorable/customizable to user needs and/or users can make modifications to suite their needs.

**Accurate** – Information provided is correct, matches reality within acceptable limits. Determinations of accuracy normally require definition of acceptable error limits.

**Timely** – The occurrence or delivery is within acceptable time limits. This can refer to an elapsed time or to meeting a schedule.

**Usable** – The system, capability, information, or process can be used. This attribute is one of the four MOE; its component MOP follow.

**Clear** – How the system or process is to be used is easily understood. Meaning of the information is easily comprehended. Instructions, guidelines, definitions are complete and meaningful.

**Trusted** – Users believe that the information, process, system, organization, will perform their function in a manner that supports current needs.

**Manageable** – The system or process can be easily modified or manipulated as needs dictate, often in response to changes in the environment. Included is insuring that the required level of performance is maintained. This includes installation of capabilities.

**Relevant** – Information provided applies to the current situation. System capabilities are what is needed for current tasks. Processes provide the actions required for current operations.

**Compliant** – The system or information complies with standards or defined structure and formats. Activities are in conformance with existing CONOPS and TTP.

**Military Utility** – Military utility is a faux attribute (not actually a description of characteristics), used to express that something contributes to the performance of military operations. It is an overarching attribute. The four measures of utility follow.

**Improved** – The system, organization, or process improves the conduct of military operations for which they were designed.

**Needed** – The system, organization, or process fills a gap an identified gap.

**Applicable** – The system, organization, or process is pertinent to conduct of the operation. Its capabilities match the needs and conduct of the operation.

**Wanted** – Operational personnel want the capability and utilize it. They do not currently have the capability or would rather use it in place of other available capabilities.

# Appendix B
**MDA Test Program Tracking**

Two types of program tracking are provided:
- Objectives and attributes being evaluated, by test venue
- Planning details for each test venue

These tracking spreadsheets are placed in a workspace folder for easy access.

Table 8 shows a small section of the objective and attribute tracking spreadsheet. Its characteristics are:
- A sheet for each Test Area
- Program objective structure Attribute assignments for each Objective Type (indicated by an "X")
- A row for each venue (rows added as venues added)
- Attributes to be evaluated (indicated by a "P")
- Attributes for which results have been obtained (indicated by an "R")

Use of the "P" and "R" indicators allows the spreadsheet to be used to track both planning and after-test results production. The Ps and Rs shown in the spreadsheet are notional, for illustration, not actual assignments.

Table 9 shows an example of the objective and measures planning spreadsheet. There is one sheet per venue. All of the entries shown are notional, not real. Only those MDA program objectives that are planned to be tested will be shown on these sheets. Spreadsheet contents are:

- MDA Obj # — Objective # from the objective structure.
- Objective Type — Objective short title from the objective structure.
- Workflow Node # that is/are being exercised for this Test Goal. — Node #(s) from the workflow architecture
- Workflow Node Name — Name of the workflow node.
- Operational Organization Cmd. — Identification of which Command(s) will be participating in this objective test.
- Operational Organization Cell within the Command that will be participating in this objective test (for data capture). — Identification of the location(s)/Cell(s)
- Supporting Systems test objective. — System(s) that will be used in support of the

- Test Objective — Specific objective for that Objective Type that will be tested. Goals statements that contain the Attributes are in FIRE.
- Test Measures determined — Specific Measure(s) whose value will be for each Attribute.

| Objective Category / Objective Type | | Accessible | Capacity | Available | Compatible | Extensive | Efficient | Reliable | Robust | Persistent | Secure | Assured | Capable | Sufficient | Flexible | Accurate | Timely | Reach | Automatic | Usable | Clear | Trusted | Manageable | Relevant | Compliant | Deployable | Improved | Needed | Applicable | Wanted | Ready |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | MOE | MOP | | | | | MOE | MOP | | | | MOE | MOP | | | | | | MOE | MOP | | | | | MOU | | | | | MOR |
| **DT** | **Detect/Track** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **DT-SD** | **Ship Detection** | X | X | | | X | X | | | X | | | S | | | X | X | X | X | | | | | | X | X | X | | X | X |
| | TW-08 | R | R | | | | | | | | | | R | | | R | R | | | | | | | | R | R | R | | R | |
| | SIMEX | | | | | P | P | | | P | | | | | | P | P | P | P | | | | | | | | | | | |
| | SEACAT | P | P | | | P | P | | | P | | | | | | P | | | | | | | | | | | | | | |
| | Venue-X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

**Table 8. Objective and attribute assessment planning, by venue.**

## MDA Planning Summary

**Venue:** name here

| MDA Obj # | Program Objective | Workflow Node # | Node Name | Operational Organization Command | Operational Organization Cell | Supporting Systems | Test Objective | Test Measures |
|---|---|---|---|---|---|---|---|---|
| DT-SD.2 | Radiating-ship detection | WF-26 | ISR Control | PACFLT | zzzz | CMA MASTER | Determine the number of ships that can be detected and reported. | **Capacity**: Number of ships reported/hour.<br>**Accurate**: Reporting CEP, nmi. |
| DT-ST.4 | Handoff | xxxxx | yyyyy | CENTCOM<br>PACFLT<br>NCIS | N2<br>N2<br>CT Cell | CMA<br>AAA | Determine if handoff is efficient. | **Automatic**: M2M handoff, y/n.<br>**Efficient**: time required for handoff (hr); number of steps required for a handoff.<br>**Sufficient**: percent of tracking information transmitted. |
| | | | | | | CENTRIX | | **Capacity**: coalition throughput. |

**Table 9. Venue objectives and measures planning.**

# Appendix C
**Task / Attribute / Measure Relationships**

As noted in Section 2.2, attributes and measures do not stand alone. They have meaning only when associated with an activity or task. Figure 3 shows the various types of task, attribute, and measure associations that are encountered in military operations assessments. It is useful to keep these associations in mind when developing MDA capability tests. It is not sufficient to test only system performance. It is also necessary to test the processes that systems serve, and the humans and organizations that execute the processes. The relationships shown in Figure 3 illustrate the types of determinations that should be made.

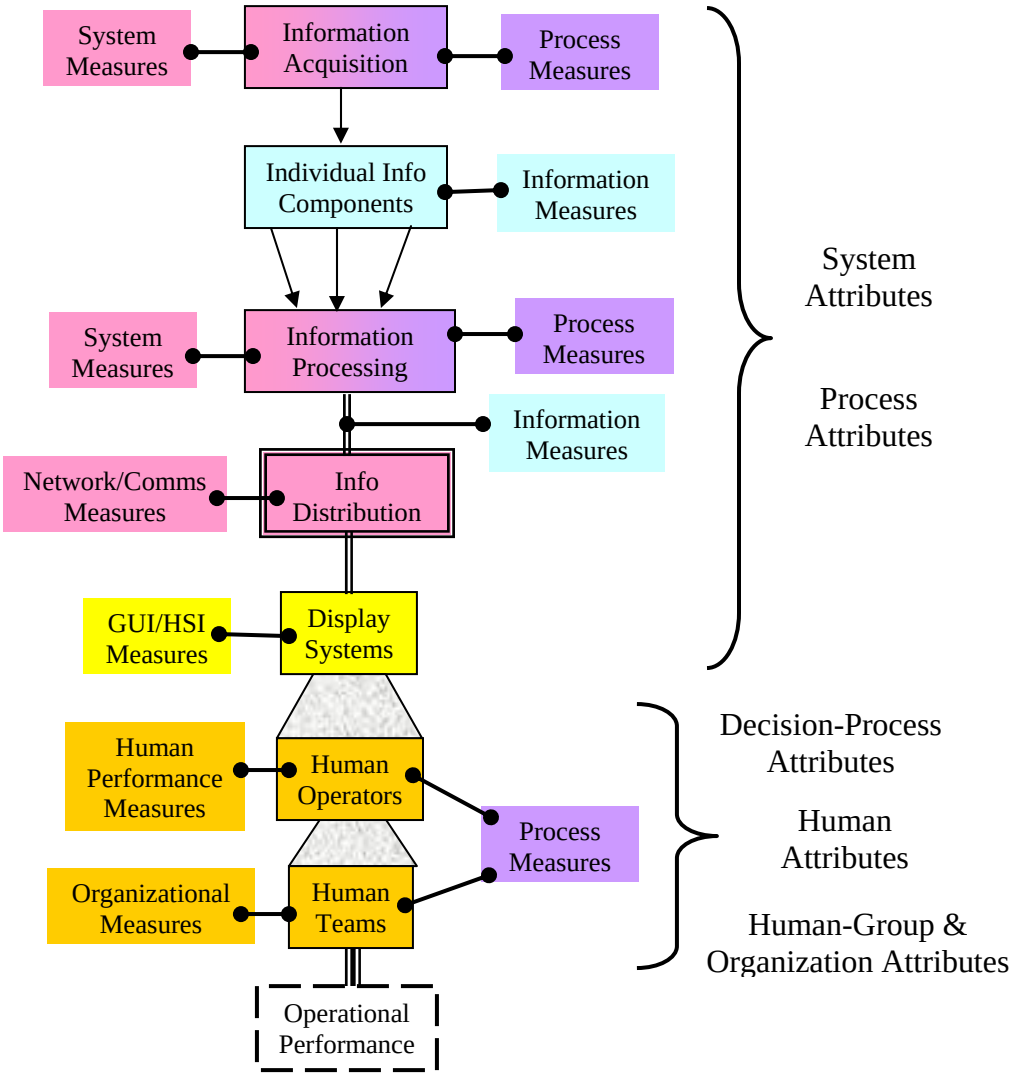


**Figure 3. Attribute and measure types and relationships to systems and activities.**

Not all associations can be shown in the figure, e.g., collaboration system performance is not shown associated with human decision processes.

The following is an example of task/attribute/measure interdependence is taken from recent development work on the NNWC Capabilities List for Joint Net-Centric Operations.

Attribute = Timely MOP = Timeliness
- Task = RFI response
  - Measures = a. Time from submission of RFI to receipt of information.
    b. Time information waits in queue for transmission.
    c. RFI processing time.
- Task = network management
  - Measures = a. Time to switch channels.
    b. Time from request to receipt of access.
- Task = information processing
  - Measures = a. Average time to develop aim-point.
    b. Fraction of mensurated targets that meet MAAP cut-off.

# Appendix D

**Program Objectives, Attributes, and Test Goals**

The structures, objectives, and metrics that have been developed for MDA testing are "program objectives". This means that they contain the overall objectives and metrics of the program. As has been described in this report, a given test venue will have a set of specific objectives, goals, measures, and data. These specifics fit within, and are derived from, the overall program structure.

Table 10 shows an example of defined test Goals, attributes and measures for DT-SD.1 and SD.4, non-radiating ship detection and automated alerting, respectively (shown in yellow in the figure). These goals are actual assignments derived from the resource documents. The thresholds listed come from the ONR S&T plan, as indicated.

Goals and measures have been defined for all of the MDA Program Objectives. They can be found in FIRE. They can be used directly for tests, or SMEs can design other goals and that fit within the Program Objectives structure.

| Goal | Attribute | Measures | Threshold | Source |
|---|---|---|---|---|
| **DT Detect/Track** | | | | |
| **DT-SD Ship Detection** | | | | |
| DT-SD.1 Non-radiating-ship detection | | | | |
| Determine Large Ship Detection Range and Accuracy | Reach<br>Accuracy | Detection Range (mi)<br>Location CEP (mi) | 2000 mi<br>5 mi | S&T |
| DT-SD.2 Radiating-ship detection | | | | |
| DT-SD.3 Plan & Optimize Collection | | | | |
| DT-SD.4 Automated alerting | | | | |
| Is Large Ship Detection alerting timely? | Timely | Time from detection to alert (hr) | 4 hr | S&T |

**Table 10. Specific Goals to be evaluated and their attributes and measures.**

The following tables list the full MDA objectives structure. Table 11 included, for each Program Area, the Activity/Focus and Program Objectives (in condensed statements). Table 12 has the principal attributes and brief indications of application for each Activity/Focus. These attributes apply to all of the activity Program Objectives and the specific ones to be used are chosen during Test Objective and goal planning.

**Table 11. Complete listing of Program Areas, Activities / Focus, and Program Objectives (on following pages 28-31).**

| Program Area<br>Activity / Focus | Program Objective |
|---|---|
| **DT** | **Detect/Track** |
| **DT-SD** | **Ship Detection** |
| DT-SD.1 | Non-radiating-ship detection |
| DT-SD.2 | Radiating-ship detection |
| DT-SD.3 | Plan & Optimize Collection |
| DT-SD.4 | Automated alerting |
| **DT-ST** | **Ship Tracking** |
| DT-ST.1 | Non-radiating-ship tracking |
| DT-ST.2 | Radiating-ship tracking |
| DT-ST.3 | AIS-broadcasting-ship tracking |
| DT-ST.4 | Handoff |
| DT-ST.5 | All ship tracking |
| **DT-Acq** | **Acquire Database Information** |
| DT-Acq.1 | Local repository retrieval |
| DT-Acq.2 | Remote repository retrieval |
| DT-Acq.3 | Cross-domain retrieval |
| DT-Acq.4 | Weather & Environment |
| DT-Acq.5 | Reachback/RFI |
| **DT-Int** | **Intelligence Collection** |
| DT-Int.1 | Collect Requirements |
| DT-Int.2 | Research RFI |
| DT-Int.3 | Validate & Prioritize Req. |
| DT-Int.4 | Synchronize Collection Req. |
| DT-Int.5 | Simulate ISR Plan |
| DT-Int.6 | Collection Plan |
| DT-Int.7 | HUMINT |
| DT-Int.8 | Alerting / I&W |
| DT-Int.9 | PED |

| Program Area<br>Activity / Focus | Program Objective |
|---|---|
| **Proc** | **Process Data & Information** |
| Proc-ID | Identify Ship's Data |
| Proc-ID.1 | Ship Characteristics |
| Proc-ID.2 | Cargo |
| Proc-ID.3 | Track History |
| Proc-ID.4 | Ship Infrastructure |
| Proc-ID.5 | Personnel |
| Proc-ID.6 | ID Information Gaps |
| Proc-Cfy | Classify Information |
| Proc-Cfy.1 | Data Pedigree |
| Proc-Cfy.2 | Data Currency |
| Proc-Cfy.3 | Information Validity |
| Proc-Cfy.4 | Assign Track ID |
| Proc-Crl | Correlate Information |
| Proc-Crl.1 | Multi-Source |
| Proc-Crl.2 | Ship Information |
| Proc-Crl.3 | Reference Data |
| Proc-Crl.4 | Intelligence information |
| Proc-Crl.5 | Track Information |
| Proc-Fus | Fuse Information |
| Proc-Fus.1 | Format Information |
| Proc-Fus.2 | Develop Total Ship Folder |
| Proc-Fus.3 | Attach Meta-Data |

| Program Area<br>**Activity / Focus** | Program Objective |
|---|---|
| **Analyze/Develop SA** | |
| Develop Profiles | |
| AD-Prof.1 | Develop Behavior Profiles |
| AD-Prof.2 | Develop Threat Profiles |
| AD-Prof.3 | Correlate With Ship Information |
| Request Information | |
| AD-Req.1 | Prioritize Information Gaps |
| AD-Req.2 | Request ISR Collection |
| AD-Req.3 | Request Database Information |
| AD-Req.4 | Request HUMINT |
| Classify Vessels | |
| AD-Cfy.1 | Classify Ships |
| AD-Cfy.2 | Anomaly Detection |
| AD-Cfy.3 | Identify VoI |
| AD-Cfy.4 | Classify VoI |
| Prioritize Information | |
| AD-Pri.1 | Prioritize Information |
| AD-Pri.2 | Prioritize Distribution |

| Program Area<br>Activity / Focus | Program Objective |
|---|---|
| **Distribute/Share** | |
| Distribution Means | |
| DS-Mns.1 | Select Distribution Means |
| DS-Mns.2 | Format for Distribution |
| DS-Mns.3 | Select / Authorize Recipients |
| Collaborate | |
| DS-Coll.1 | Authorize Participants |
| DS-Coll.2 | Prepare Information |
| DS-Coll.3 | Display Information |
| DS-Coll.4 | Manage Collaboration |
| Disseminate | |
| DS-Dis.1 | Optimize Distribution Paths |
| DS-Dis.2 | Update Databases |
| DS-Dis.3 | Push Information |
| DS-Dis.4 | Alert Recipients |

| Program Area<br>**Activity / Focus** | Program Objective |
|---|---|
| **Database Archive/Retrieve** | |
| Deploy Databases | |
| DB-Dep.1 | Local Repository |
| DB-Dep.2 | Central Repository |
| DB-Dep.3 | Multi-Level Guards |
| DB-Dep.4 | Cross-Domain Repositories |
| Acquire Information | |
| DB-Acq.1 | Human |
| DB-Acq.2 | Ship |
| DB-Acq.3 | Ship Status / Tracks |
| DB-Acq.4 | Environment |
| DB-Acq.5 | Cargo |
| DB-Acq.6 | Intelligence |

| Program Area<br>Activity / Focus | Program Objective |
|---|---|
| **Guidance** | |
| TTP & SOP | |
| G-TTP.1 | Distribution |
| G-TTP.2 | Operations Coverage |
| G-TTP.3 | Situation Coverage |
| G-TTP.4 | Operational/Tactical Threads |
| G-TTP.5 | Technology Inclusion |
| CONOPS | |
| G-CPS.1 | Command Relationships |
| G-CPS.2 | Operations Coverage |
| G-CPS.3 | Situation Coverage |
| G-CPS.4 | Operational/Tactical Threads |
| G-CPS.5 | Technology Inclusion |

| | |
|---|---|
| **Authenticate Information** | |
| DB-Ath.1 | Authenticate Source |
| DB-Ath.2 | Assure Source |
| DB-Ath.3 | Attach Metadata |
| DB-Ath.4 | Assure Information Quality |
| **Manage Access** | |
| DB-Acc.1 | Authorize Users |
| DB-Acc.2 | Profile Users |
| DB-Acc.3 | Provide/Control Access |
| **Assure Information** | |
| DB-Ass.1 | Monitor Repository Status |
| DB-Ass.2 | Protect Repositories |
| DB-Ass.3 | Detect Unauthorized Access |
| DB-Ass.4 | Detect Information Defects |
| DB-Ass.5 | Status Alerting |
| DB-Ass.6 | Failover |
| DB-Ass.7 | Repair Defects |

| | |
|---|---|
| G-CPS.6 | Quality of Instructions |
| **Standing Orders** | |
| G-SO.1 | Distribution |
| G-SO.2 | Match to Situation |
| G-SO.3 | Updating |
| G-SO.4 | Quality of Orders |
| **Cross-Organization Agreements** | |
| G-CO.1 | Multi-Command |
| G-CO.2 | Multi-Department |
| G-CO.3 | Multi-National |

| **Program Area**<br>**Activity / Focus** | Program Objective |
|---|---|
| **Workflow** | |
| Task Assignments | |
| W-Arch.1 | Task Organization |
| W-Arch.2 | Information Flow |
| W-Arch.3 | Prioritization |
| W-Arch.4 | Workflow |
| Organization | |
| W-Org.1 | Organization Structure |
| W-Org.2 | Command Relationships |
| W-Org.3 | Organization Dynamics |
| W-Org.4 | Situation/Organization Match |
| W-Org.5 | Communications Structure |
| W-Org.6 | Adaptation |
| W-Org.7 | Performance |
| Group | |
| W-Grp.1 | Group Competence |
| W-Grp.2 | Activities Understanding |
| W-Grp.3 | Situation/Group Structure Match |
| W-Grp.4 | Performance |

| **Program Area**<br>Activity / Focus | Program Objective |
|---|---|
| **E-MIO Operations** | |
| Information Acquisition | |
| MIO-Acq.1 | Vessel Characteristics |
| MIO-Acq.2 | Threat Assessment |
| MIO-Acq.3 | Rules and Orders |
| MIO-Acq.4 | Available Assets Status |
| MIO-Acq.5 | Formulate/issue RFIs |
| MIO-Acq.6 | Environment/Weather |
| Develop Situation Understanding | |
| MIO-SU.1 | Correlate Information |
| MIO-SU.2 | Track/VoI Status |
| MIO-SU.3 | Assess Tactical Environ. |
| MIO-SU.4 | Assess Hazards |
| MIO-SU.5 | Assess Urgency |
| MIO-SU.6 | Infer VoI Intent |
| Course-of-Action | |
| MIO-CoA.1 | Collaborate, Develop CoA |
| MIO-CoA.2 | Simulate CoA |
| MIO-CoA.3 | Present CoA |

| | |
|---|---|
| W-Grp.5 | Capabilities/Task Match |
| W-Grp.6 | Adaptation |
| W-Grp.7 | Workload |
| **Human** | |
| W-Hum.1 | Competence |
| W-Hum.2 | Task Understanding |
| W-Hum.3 | Performance |
| W-Hum.4 | Capabilities/Task Match |
| W-Hum.5 | Adaptation |
| W-Hum.6 | Workload |
| **Multi-Organization Workflow** | |
| W-MOrg.1 | Organization Structure |
| W-MOrg.2 | Command Relationships |
| W-MOrg.3 | Organization Dynamics |
| W-MOrg.4 | Situation/Organization Match |
| W-MOrg.5 | Communications Structure |
| W-MOrg.6 | Adaptation |
| W-MOrg.7 | Performance |

| | |
|---|---|
| MIO-CoA.4 | Select COA |
| MIO-CoA.5 | Develop Tasking |
| MIO-CoA.6 | Develop Safety Plan |
| MIO-CoA.7 | Disseminate Tasking |
| **Boarding Execution** | |
| MIO-Brd.1 | Insure Safety |
| MIO-Brd.2 | Execute Boarding |
| MIO-Brd.3 | Direct Forces |
| MIO-Brd.4 | Cross-Domain Collaboration |
| MIO-Brd.5 | Real-Time Reporting |
| MIO-Brd.6 | Visual/TV Monitoring |
| MIO-Brd.7 | Mission Reports |
| MIO-Brd.8 | Dynamic Re-Tasking |
| **Shipboard Collection** | |
| MIO-Coll.1 | CBNRM |
| MIO-Coll.2 | Biometrics |
| MIO-Coll.3 | Ship Information |
| MIO-Coll.4 | Cargo |
| MIO-Coll.5 | Video |
| **Information Dissemination** | |
| MIO-Dis.1 | RHIB Relay |
| MIO-Dis.2 | LOS |
| MIO-Dis.3 | VOI Internal |
| MIO-Dis.4 | SATCOM |
| MIO-Dis.5 | OTH |
| **Mission Assessment** | |
| MIO-Ass.1 | Real-Time Assessment |
| MIO-Ass.2 | Real-Time Feedback |
| EM-Ass.3 | After-Action Assessment |
| EM-Ass.4 | Database Update |
| EM-Ass.5 | Assessment Dissemination |

Table 12 contains principal attributes for MDA activities and test foci. For each attribute there is included an application which, indicates the type of measure that is to be produced. Neither the attributes nor their application is complete; others may be used in developing a test. Application is shown rather than an actual measure for simplicity, showing the focus.

**Table 12. Program Area Activity / Focus and their Attributes and attribute applications (on following pages 33-37).**

| Program Area<br>Activity / Focus | |
|---|---|
| Attribute | Application |
| **DT Detect/Track** | |
| **DT-SD Ship Detection** | |
| Extensive | area covered, % of AOR |
| Accurate | location and ID |
| Timely | reporting delays, alerts |
| Efficient | collection planning |
| Persistent | collection, monitoring |
| Capacity | simultaneous # of ships |
| Deployable | detection system |
| Reach | detection range |
| **DT-ST Ship Tracking** | |
| Accessible | area to be monitored |
| Available | information to users |
| Persistent | tracking |
| Efficient | handoff |
| Accurate | location and ID |
| Timely | reporting delay |
| Automatic | tracking and alerting |
| **DT-Acq Acquire Database Information** | |
| Accessible | repository to users |
| compatible | information formats, systems |
| Available | repository information |
| Robust | against penetration, corruption |
| Capacity | information throughput |
| Reliable | information availability |
| **DT-Int Intelligence Collection** | |
| Accurate | data/information collected |
| Sufficient | ISR resources |
| Timely | RFI response, I&W alerts |
| Trusted | data sources |
| Assured | data pedigree |
| Compliant | priorities to requirements |
| Relevant | collection plan to requirements |
| Available | information sources |
| Persistent | collection |

| Program Area<br>Activity / Focus | |
|---|---|
| Attribute | Application |
| **Proc Process Data & Information** | |
| Proc-ID | Identify Ship's Data |
| Capacity | # of tracks, data amount |
| Accurate | ship/data association |
| Automatic | data entry, categorization |
| Assured | data pedigree |
| Proc-Cfy | Classify Information |
| Efficient | automation, personnel savings |
| Timely | time to classify |
| Assured | information pedigree |
| Accurate | classification, track number |
| Automatic | classification |
| Proc-Crl | Correlate Information |
| Capacity | number of ships, sources |
| Compatible | data formats, systems |
| Flexible | number of source types |
| Assured | data pedigree, source |
| Automatic | ID, correlation |
| Timely | time per ship |
| Proc-Fus | Fuse Information |
| Capacity | number of ships, sources |
| Compatible | data formats, systems |
| Flexible | number of source types |
| Assured | data pedigree, source |
| Automatic | fusion |
| Timely | time per ship |
| Accurate | ship association |

| Program Area<br>**Activity / Focus** | |
|---|---|
| Attribute | Application |
| **Analyze/Develop SA** | |
| Develop Profiles | |
| Automatic | profile generation, correlation |
| Automatic | Anomaly Detection |
| Timely | alerts |
| Flexible | number of profile types |
| Accurate | profiles, threat ID |
| Clear | profile structure, relationships |
| AD-Prof.3 | Correlate With Ship Information |
| Request Information | |
| Relevant | information gap ID |
| Available | information sources |
| Timely | RFI development, submission |
| Compliant | request format |
| Classify Vessels | |
| Accessible | reference data, including M2M |
| Capacity | # of classifications, data amount |
| Automatic | classification, VoI ID, prioritization |
| Available | required data sources |
| Prioritize Information | |
| Sufficient | information for prioritization |
| Relevant | priorities to situation |
| Flexible | # of priority types |
| Compliant | priorities with orders, situation |
| Capacity | # of tracks prioritized |

| Program Area<br>Activity / Focus | |
|---|---|
| Attribute | Application |
| **Distribute/Share** | |
| Distribution Means | |
| Compatible | data, systems, protocols |
| Deployable | to platforms, units |
| Capacity | bandwidth, # paths, throughput |
| Manageable | auto-failover, status reports |
| Automatic | prioritization, means, distribution |
| Accurate | data drops, jitter |
| Collaborate | |
| Available | collaboration toolkit |
| Reliable | tools availability, functionality |
| Flexible | presentation means |
| Timely | time to join, establish session |
| Reach | number of users |
| Manageable | reconfigurable, user & status rpts. |
| Disseminate | |
| Timely | transmission time, alerts |
| Available | selected transmission option |
| Reach | distribution area, # of customers |
| Robust | automatic redirect, jamming |
| Automatic | distribution recipient, alerts |
| Persistent | network available |
| Flexible | # of distribution options |
| Assured | delivery receipt |

| Program Area<br>**Activity / Focus** | |
|---|---|
| Attribute | Application |
| **Database Archive/Retrieve** | |
| Deploy Databases | |
| Capacity | storage, information types |
| Manageable | automated recovery, status reports |
| Compatible | systems, protocols interoperability |
| Acquire Information | |
| Automatic | data pull, archiving |
| Available | external data, data to users |
| Accessible | user to repository, data pull |
| Compatible | systems, formats |
| Flexible | source types, data types. Formats |
| Authenticate Information | |
| Assured | source logging, pedigree, marking |
| Compliant | with standards |
| Manage Access | |
| Extensive | # of users, profiles managed |
| Flexible | # of user types, networks |
| Secure | # unauthorized uses |
| Persistent | access, down time |
| Manageable | set-up efficiency, profiles |
| Assure Information | |
| Extensive | IA across domains |
| Robust | backup, failover, down time |
| Sufficient | IA processes and systems |
| Available | repository monitoring |
| Manageable | status reports accuracy, access |
| Timely | defect repair |
| Automatic | status reporting and alerting |

| Program Area<br>Activity / Focus | |
|---|---|
| Attribute | Application |
| **Guidance** | |
| TTP & SOP | |
| Available | promulgated and on hand |
| Compatible | across nations and units |
| Compliant | with doctrine & directives |
| Flexible | alternate actions described |
| Trusted | outcomes produced |
| Relevant | applies to the situation |
| Clear | directions |
| CONOPS | |
| Available | promulgated and on hand |
| Compatible | across nations and units |
| Compliant | with doctrine & directives |
| Flexible | alternate actions described |
| Trusted | outcomes produced |
| Relevant | applies to the situation |
| Clear | directions |
| Standing Orders | |
| Available | promulgated and on hand |
| Compatible | across nations and units |
| Compliant | with doctrine & directives |
| Flexible | alternate actions described |
| Trusted | outcomes produced |
| Relevant | applies to the situation |
| Clear | directions |
| Cross-Organization Agreements | |
| Compatible | national doctrine, CONOPS |
| Available | in existence |
| Clear | understood at all levels |
| Extensive | # of situations |
| Sufficient | coverage of situation |

| Program Area<br>**Activity / Focus** | |
|---|---|
| Attribute | Application |
| **Workflow** | |
| Task Assignments | |
| Sufficient | task coverage, information products |
| Efficient | task performance, work required |
| Clear | personnel understand |
| Timely | information for task |
| Flexible | to changing technologies, situations |
| Compatible | across MOCs and units |
| Organization | |
| Efficient | task performance, work required |
| Compatible | across MOCs, units, and nations |
| Sufficient | covers requirements, needs |
| Flexible | to changing CONOPS, agreements |
| Timely | information delivery |
| Trusted | decision processes |
| Group | |
| Flexible | to changing missions |
| Manageable | for personnel turnover |
| Compatible | skills match tasks |
| Capacity | to handle workload |
| Sufficient | training to achieve competence |
| Deployable | for command portability |
| Human | |
| Flexible | to task assignments, workflow |
| Sufficient | training to achieve competence |
| Compatible | skills to task match |
| Robust | to changing situation |
| Capable | task performance |
| Accurate | task performance |
| Capacity | workload |
| Multi-Organization Workflow | |
| Flexible | to different missions, situations |
| Clear | cross-organization task handoff |
| Trusted | cross-organization products |
| Compatible | cross-organization workflow |
| Compatible | cross-organization products |

| Program Area<br>Activity / Focus | |
|---|---|
| Attribute | Application |
| **E-MIO Operations** | |
| Information Acquisition | |
| Available | needed info and databases |
| Sufficient | information for assessments |
| Relevant | information applies to situation |
| Accurate | information |
| Timely | information updates, freshness |
| Develop Situation Understanding | |
| Capacity | number of ships evaluated |
| Efficient | time required per ship |
| Flexible | information types, ship types |
| Sufficient | SU for CoA development |
| Relevant | evaluation to situation |
| Compatible | with command priority |
| Course-of-Action | |
| Efficient | CoA development time |
| Flexible | CoA considered, options |
| Relevant | to situation, command priority |
| Compliant | with command priority |
| Sufficient | information for CoA decision |
| Timely | in time for execution |
| Clear | CoA options, actions |
| Boarding Execution | |
| Clear | tasking, execution reports |
| Timely | execution of tasking |
| Accurate | taking execution |
| Flexible | immediate situation response |
| Deployable | execution forces |
| Sufficient | forces for execution |
| Reliable | execution reporting |
| Compliant | execution with directions |
| Shipboard Collection | |
| Accessible | ship, personnel, manifests |
| Capacity | total biometrics |
| Accurate | data collection |
| Timely | data collection |

| | |
|---|---|
| Trusted | data collection devices |
| Sufficient | data collection for threat eval |
| **Information Dissemination** | |
| Accessible | comms paths, internal & external |
| Capacity | throughput |
| Timely | data receipt |
| Manageable | communications architecture |
| Secure | communications paths |
| Flexible | path switching, data formats |
| **Mission Assessment** | |
| Sufficient | assessment for decisions |
| Clear | assessment for decisions |
| Timely | in time for re-tasking |
| Relevant | to situation, priorities, intent |
| Accurate | relation to ground truth |

# Appendix E
**Mapping to JCIDS JCAs**

Mapping MDA activities to the JCIDS JCAs is not part of this project. However, it may be useful at some point to do so. The purpose of this appendix is to illustrate the method that has been developed to do such mapping.

Structures and methods have been developed for NAVNETWARCOM to map their capabilities lists to the JCIDS JCAs. (See "Mapping Experiment Results to Operational Capabilities", NPS-97-08-001, Nov 2007). Mapping is done through correlation of operational activities using an Operational Activities Set. The MDA program objectives presented in this report are consistent with the Operational Activities Set.

## E.1 Operational Activity Set

The JCAs include supporting and supported activities. The supported activities structure follows the classic OODA loop. The supporting activities are generally accepted to be Net-Centric Operations, Battlespace Awareness, and C2. In addition to OODA, they have their own structure, designated "Service", to include such things as network installation.

The Operational Activity Set has a 3-level structure:

- Level-1, Operational Area (e.g., land operations, surface warfare, battlespace awareness).
- Level-2, Activity Category
    - Observe
    - Orient
    - Decide
    - Act
    - Service
- Level-3 contains Activity Types under each of these Categories
- Level-4 contains Tasks under each Activity Type

Table 13 lists the Activity Categories and Types. The chronological view of activities presented in Table 13 is the most intuitive and illustrates information development. For example, the table shows that data is processed into information in the Observe phase, distributed, then acquired and processed into SA in the Orient phase (note the overlaps of distribute and acquire to illustrate their overlap and interdependence).

| Observe | Orient | Decide | Act | Service |
|---|---|---|---|---|
| Ob-Plan | | | | *Continuous* |
| Ob-AcqD | | | | \| |
| Ob-ProcD | | | | S-Plan |
| Ob-DisI | Or-AcqI | | | \| |
| | Or-ProcI | | | S-Acquire |
| | Or-DevSA | | | \| |
| | Or-ShrSA | | | S-Manage |
| | Or-PntSA | D-AcqK | | \| |
| | Or-Guide | D-DevSU | | S-Assure |
| | | D-ShrSU | | \| |
| | | D-DevCoA | | S-Authorize |
| | | D-PntCoA | | \| |
| | | D-CoA | | S-Distribute |
| | | D-DevT | | \| |
| | | D-DisT | A-AcqT | S-Instruct |
| | | | A-DisUT | \| |
| | | | A-Ex | \| |
| | | | A-ExMon | \| |
| | | | A-ExRprt | \| |

D = Data
I = Information
K = Knowledge
SA = Sit. Aware.
SU = Sit. Under.
T = Tasking
Mon = Monitor
Rprt = Report
Ex = Execute
Acq = Acquire
Proc = Process
Dis = Distribute
Shr = Share
Dev = Develop
UT = Unit Tasking
Guide = Guidance

**Table 13. Chronological Operational Activities Category and Type.**

Table 14 presents a view of the set that illustrates the commonality of activities across the OODA categories.

| Activity Type | Category | | | | |
|---|---|---|---|---|---|
| | Observe | Orient | Decide | Act | Service |
| **Plan** | Ob-Plan | | | | |
| **Acquire** | Ob-AcqD | Or-AcqI | D-AcqK | A-AcqT | Plan |
| **Process** | Ob-ProcD | Or-ProcI | | | |
| **Develop** | | Or-DevSA | D-DevSU | | Acquire |
| | | | D-DevCoA | | |
| **Distribute** | Ob-DisI | Or-ShrSA | D-DisT | A-DisT | Manage |
| **Present** | | Or-PntSA | D-PntSU | | |
| | | | D-PntCoA | | Assure |
| **Execute** | | | | A-Ex | |
| | | | | A-ExMon | Authorize |
| | | | | A-ExRprt | |
| **Guidance** | | Or-Guide | D-CoA | | Distribute |
| | | | D-DevT | | |

| | | | | | |
|---|---|---|---|---|---|
| | | | | | Instruct |

**Table 14. Operational Activity Set sorted by Activity-Type.**

A complete description of the Operational Activity set is found in the NPS report: "Mapping Experiment Results to Operational Capabilities", NPS-97-08-001, Nov 2007.

### E.2 Mapping MDA Test Results

Mapping MDA test to the MDA program is, of course direct. Mapping to other areas is done via the Operational Activity Set and the mapping of that Set to those areas. The process is straightforward and Figure 4 illustrates its rudiments.

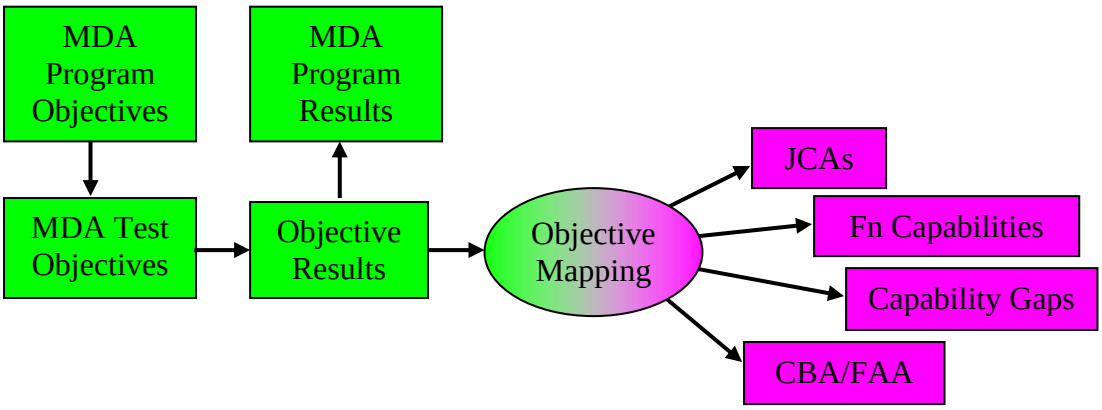


**Figure 4. Mapping MDA results to MDA program objectives and to other areas.**

## 5. MDA in the FIRE Knowledge Management System

NPS has developed the FORCEnet Innovation and Research Enterprise (FIRE) to provide complete support for experiment and test planning and reporting. An MDA section has been set up in FIRE, implementing the structure described above. In this chapter, we describe the system's capabilities and how it is used.

*It is important to recognize that the objective statements in FIRE are Test Objectives. They are the actual objectives to be achieved and their status addressed in a test venue*

### 5.1 FIRE Structure

FIRE has two basic sections, Planning Forms and Workspace:

**Planning Forms**

- Detailed planning is accomplished through entries in pre-set forms.
- There are three sets of planning forms
  - Objective
  - Data/Events
  - Results
- Each forms set includes
  - Input/Edit form
  - Report that shows the current planning database content

**Workspace**

- Contains collaboration capabilities and folders for information to be shared
- Pre-created folders and user defined folders
- Check-in/check-out library for document version control

Following is a depiction of the principal components of the planning forms.

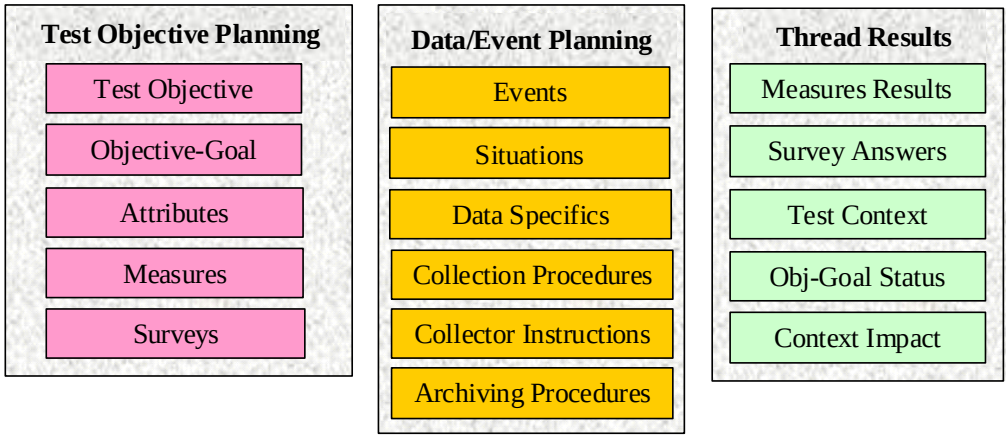


**Figure 1. Principal components of the MDA planning forms in FIRE.**

# Initial Distribution List

1. The Naval Postgraduate School — 1
   1411 Cunningham Road, Code 06IS
   Monterey, CA 93943

2. Dudley Knox Library, Code 013 — 1
   Naval Postgraduate School
   Monterey, CA 93943-5100

3. Research Office, 09 — 1
   Naval Postgraduate School
   Monterey, CA 93943

4. Defense Technical Information Center — 2
   8725 John J Kingman Road, Suite 0944
   Fort Belvoir, VA 22060-6218

5. CDR Dan Dunaway — 1
   Office of the Deputy Under Secretary of the Navy
   1000 Navy Pentagon, Room 4E720
   Washington, DC 20350-1000

6. Mr. Richard Volkert — 1
   Commanding Officer
   (Attn: R. Volkert, Bldg 1 Rm A526)
   Space & Naval Warfare Systems Center – Pacific
   53560 Hull Street
   San Diego, CA 92152-5001

7. LTC Mark J. Gruber — 1
   Technical Director
   Joint Integrated Command and Control for
   Maritime Homeland Defense Operations (JICM)
   JICM JT&E
   250 South Peterson Blvd
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   Deputy Director
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9. Mr. George Galdorisi (Via e-mail) 1

10. Dr. Douglas J. MacKinnon (Via e-mail) 1

11. Dr. Shelley Gallup (Via e-mail) 1

12. Mr. Jack Jensen (Via e-mail) 1

13. Ms. Susan Hutchins (Via e-mail) 1

14. Dr. Gordon Schacher (Via e-mail) 1

15. Mr. David Rousseau (Via e-mail) 1